



**QUEEN'S
UNIVERSITY
BELFAST**

Supply Chain Management in Confined Site Construction: Strategies to Reduce Delay in the Delivery of Materials to Site

Spillane, J. P., Cahill, G., Oyedele, L. O., Von Meding, J., & Konanahalli, A. (2013). *Supply Chain Management in Confined Site Construction: Strategies to Reduce Delay in the Delivery of Materials to Site*. Paper presented at RICS COBRA 2013 Research Conference, New Delhi, India. <http://www.escl.org/node/73>

Document Version:
Other version

Queen's University Belfast - Research Portal:
[Link to publication record in Queen's University Belfast Research Portal](#)

Publisher rights
© 2013 The Authors

General rights
Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact openaccess@qub.ac.uk.



RICS COBRA 2013

SUPPLY CHAIN MANAGEMENT IN CONFINED SITE CONSTRUCTION: CRITICAL SUCCESS FACTORS IN THE DELIVERY OF MATERIALS TO SITE

John P. Spillane¹, George Cahill¹, Lukumon O. Oyedele², Jason K. von Meding¹ and Ashwini Konanahalli¹

¹School of Planning, Architecture and Civil Engineering, David Keir Building, Stranmillis Road, Queen's University Belfast, Belfast, Northern Ireland, BT9 5AG, UK

²School of Architecture, University of Lincoln, Brayford Pool, Lincoln, Lincolnshire, LN6 7TS, UK

ABSTRACT

With the increase in construction in dense urban environments, the delays associated with managing the material supply chain to site is called into question. Purpose: The aim of this investigation is to gain the perspective of construction contractors operating in a dense urban environment and the resulting strategies adopted to reduce delays in the delivery of materials to site. Methodology: This is achieved through incorporating a comprehensive literature review on the subject in conjunction with industry interviews with construction professionals in the identification of various management issues and corresponding strategies in the reduction of delays in the delivery of materials to site. Findings: The key issue which emerges is the lack of space for unloading bays while the corresponding key strategy is to schedule deliveries outside peak congestion times. Practical Implication: With confined site construction evident throughout the industry and the noted importance of an effective supply chain, the findings here in further assist on-site management in the daily task of ensuring the effective delivery and off-loading of materials in a complex and hazardous environment. Originality/Value: This research aids on-site management of confined site environments in the coordination of the material supply chain to site.

Keywords: JIT, materials management, off-site logistics, Urban Development.

INTRODUCTION

In recent times, there has been a significant increase in global population growth (United Nations 2010, 2012). This global population explosion has not only put strain on the world's natural resources in terms of oil, gas and coal, but also in terms of building materials such as timber, concrete and steel but to name a few (Brinkman, et al. 2011). This pressure on the world's resources can be attributed to the greater

¹ j.spillane@qub.ac.uk

demand for infrastructure, housing, utilities, factories and businesses, due to the rise in population and the attempt to accommodate it, particularly in developing countries (Gunhan and Arditi 2005). It has also been found that globally it is becoming increasingly more common for citizens to move towards large towns and cities, and, for the first time in history, the number of people living in urban areas exceeds the number of people living in rural areas by the year 2007 (Li, et al. 2007), therefore reinforcing the creation of high density urbanisation within and around large conurbations located globally.

Within recent times, the management of materials has developed substantially; a point which resonates within the construction industry. Such practitioners as Vrijhoefa and Koskela (2000), Akintoye, et al. (2000) and Bowersox and Closs (1996) all consider logistics and supply chain management in the construction sector. Within the remit of supply chain management, Agapiou, et al. (1998a), Akintoye, et al. (2000) and Voordijk, et al. (2000) all concur that this aspect of material management is fundamentally important to the overall management of material both in the delivery to, unloading, transportation on-site and final placement within the project in question. However, with the vast majority of those highlighted, they concentrate on the aspect of the delivery of materials around site, where research has neglected to review the aspect of the delivery of material to site; thus a dearth in knowledge emerges where a lack of knowledge and understanding emerges in the management of this process in urban environments, where spatial limitations are present. Through effective supply chain management, there is a necessity not only to manage the delivery of materials in and around site, but also the management of the numerous stakeholders in the coordination of the resources to acquire and deliver the materials to site (Swaminathan, et al. 1998).

To this end, this study aims to investigate the challenges of urban development and the management of the supply chain to site. It will encompass new issues which are specific to urban development and supply chain management within the capacity of confined site municipal developments and the congested surrounding urban environment. Previous studies in relation to materials management are largely restricted to the confined site aspects, (Morana and Gonzalez-Feliu 2010; Spillane, et al. 2011), where the urban development aspects acting on the supply chain are included, but not investigated in detail. In addition, the perspectives of the contractors are more widely investigated in the literature surrounding this topic (Spillane, et al. 2011), where the viewpoint of suppliers is neglected and void of investigation. The objective of this research is to document and highlight the importance of and benefit of effective stakeholder collaboration, thus resulting in increased effectiveness and efficiencies between the various parties concerned. The results illustrate that through full cooperation from all industry partners around the interaction of suppliers and contractors collaborating together, timely and economical delivery of materials to site can be achieved. With high density urban environments evident in towns and cities around the world, this creates additional complexities for the construction industry supply chain. With this increase in urban development brings new challenges for those responsible for the delivery of inherently complex and intrinsically difficult projects and working relations, with additional complications in the pursuance of successfully completing detailed projects within an urban environment.

URBAN DEVELOPMENT AND SUPPLY CHAIN MANAGEMENT

The demand on urban infrastructure has reached and in some cases, exceeded the threshold of usage. Regardless of location, existing urban infrastructure is in urgent

need of revitalisation and redevelopment (Bourne 2010). Many urban centres rely on poorly designed, inadequately maintained or inappropriately utilised facilities that are, in many cases, more of an impediment to growth than a catalyst for development. Bloom and Khanna (2008) rightfully articulate that urbanisation can be a catalyst for productivity, development and growth, resulting in further progression and expansion of urban centres. With the population explosion evident worldwide resulting in urban areas swelling as a result, there too come difficulties in the management of the development and progression of such environments (United Nations 2010, 2012). With the continued unrelenting development of these urban centres (Roberts and Sykes 2000; Jones and Evans 2008), thus resulting in the subsequent rise in redevelopment and expansion, coupled with the supplementary complexities associated with construction projects in urban areas, this will result in increased problems which the supply chain interface in the delivery of material to the various sites located in and around the numerous conurbations under development. Sears, et al. (2008) succinctly articulates the importance of supply chain management within urban environments but again reviews this process from the aspect of the contractor while neglecting the perspective of the supplier and their interaction to the process.

Naturally, the larger the urban area, the greater the complexities in managing the successful delivery, off-loading and ultimate relocation process of material deliveries to site. The difficulty in this process is exasperated where larger sized developments are located within an urban setting, as well as the larger volume of construction materials required, combined with the potential lack of storage space on-site, where clients insist that the available footprint of a building is maximised in order to exploit the potential return in revenue obtained through capitalising on the available space (Jones 1995). Recently, for such large-scale developments in highly urban areas such as London, there has been a focus on utilising Construction Consolidation Centres in order to achieve the successful delivery of materials. It is generally accepted that the use of such centres would operate as a distribution centre for construction materials and other equipment used on construction projects within a pre-assigned radius. Importantly, it is not a warehouse for the long-term storage of materials, but acts as a short-term holding or transshipment point (Peter Brett Associates 2007), as depicted in Figure 1 (Constructing Excellence 2006).

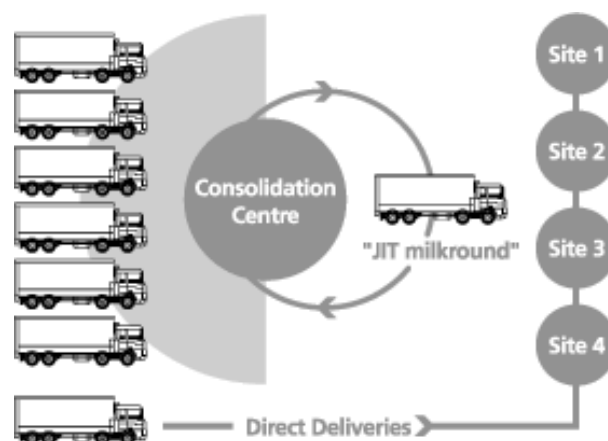


Figure 1: Construction Consolidation Centres

With many urban confined site environments, the location of the site entrance or the site itself can be an issue. The role of logistics management and supply chain management are essential in the management of materials, as is the location of the site entrance, both prior to arriving on-site and during the delivery and unloading process.

The ability to design and accommodate adequate logistics management plans, site layout plans and materials management plans are all essential in the management of the transportation of materials both unto and around site (Spillane et al., 2011). This highlights the importance of pre-planning and collaboration between site layout, material delivery and supply chain management between the various stakeholders.

METHODOLOGY

In order to address the dearth of knowledge present while also providing a reasoned discussion and objective conclusion to the research in focus, a sequential qualitative methodology is adopted as follows.

Review of the literature

In order to identify and clarify the numerous factors for consideration in this study, a desk based exhaustive critique of the literature is undertaken, including books, conference proceedings, peer reviewed journal papers and various websites, but to name a few. This provides the foundation on which the research can move forward to the interview process, providing the researcher with a thorough grounding on the core points in review, while also providing an opportunity to clarify any of the factors identified via the interviewees questioned.

Industry focused interviews

To assist in the development and confirmation of the factors for consideration, a contractor and supplier located on two different projects within an urban environment, are interviewed. In each of the cases, the participants are chosen based on selective and convenience sampling of confined construction sites located within urban context. Each of the participants works closely together on their respective projects and therefore has an identifiable cohesion in the relevant issues pertinent to each of the case studies in question. Each of the interviewees in question are located within Northern Ireland and both sets of contractors and suppliers were currently engaged on two different city centre projects, each with its own characteristics, but both confined construction projects within an urban environment. Each of the contractors is interviewed on-site and their respective suppliers interviewed at their corresponding distribution centre. On average, the interviews took forty five minutes, where a semi-structured approach is adopted, to aid fluidity and avoid restricting the direction and content in discussion. Each of the corresponding interviews is analysed using cognitive mapping to aid in the dissemination and articulation of the key points within each of the respective interviews. On completion, both the contractors and supplier data is pooled into an overall cognitive map for further analysis and discussion. This process is undertaken using cluster analysis, where a model is scrutinised and a core list of factors identified based on similar links between concepts. Hieset analysis is also introduced where the root concepts within the overall map are identified.

DISCUSSION

On review of the factors identified in the literature, compounded and articulated further by the comments of the contractors and suppliers interviewed, it is possible to decipher the overall contractor and supplier cognitive map using both cluster and hieset analysis accordingly. A number of core issues and strategies resonate throughout both sets of data and are consolidated and detailed respectively.

Lack of storage/offloading space to accommodate deliveries

The first aspect for consideration encapsulates the core issues in the management of material delivery to site within an urban, confined construction site. Within this context, a number of core issues emerge and are discussed, based on the review of the literature and case study interviewees questioned. The first aspect for review is the lack of offloading space in the vicinity of an urbanely located confined construction site. Agapiou, et al. (1998b) appropriately highlights the importance of logistics management in the material coordination process from the flow of materials from suppliers to those on-site. With such difficulties, all of the interviewees approached, all concur that this is of significant strain in the management of material delivery and more importantly, safe and effective material offloading, were public interaction makes the process even more perilous to all concerned. To mitigate such issues, the contractor based interviewees highlight the importance of pre-empting deliveries in order to put accommodation measures in place to alleviate such concerns.

Subsequently, suppliers also acknowledge the difficulties faced and agree that effective management and information transfer, in conjunction with having experienced and adequately trained delivery drivers employed, as being at the heart of the evasive approach to the issue.

The second core pointed noted in the analysis of the interviewees, specifically with regard to suppliers, is the issue of a lack of storage or hard standing space at or in the vicinity of the offloading bays of urban, confined construction sites. Again, with spatial restrictions present in and around the vicinity of many urban developments, the difficulty in the accommodation of deliveries to site requires constant management interface and proactive interaction to maximise the efficiency of the delivery process, thus minimising the contact time spent by delivery drivers and contractors outside the perimeter of a construction site.

Mutually agreeable delivery schedules outside peak congestion times

One of the first and most pertinent factors identifiable in both sets of data is the need for mutually agreeable delivery schedules between contractors and suppliers. This factor is closely linked to ‘reduction of material delivery delays’ where all of the parties questioned acknowledge that the agreement process revolves around this premise, with a view to ‘scheduling deliveries outside peak congestion times’. However, Hancher and Taylor (2007) also acknowledge that this process is not always trouble free, due to the difficulties of effective and safe material handling by operatives and the interaction with the public. Assaf and Al-Hejji (2006) compound the difficulties of material management, specifically on large construction projects – many of which are often located in large urban centres. In relation to the aspect of mutual agreement and co-operation, Ala-Risku and Kärkkäinen (2006) identify that one of the key solutions to achieve and maintain successful material delivery in construction projects, is transparency of material availability. Furthermore, once delivery has been agreed, the interviewees all concur that all parties must document and adhere to strict delivery protocol, to maintain a strict delivery schedule. This is essential in the management of deliveries where spatial constraints are ever present and where the previous point documents the plethora of issues in the delivery and offloading process on sites within urban locations.

To counteract such grievances Akintoye (1995), among others, highlight the use of Just-In-Time material delivery based on stakeholder engagement and consent as to the delivery requirements agreed. But in order to ensure that this methodology is effective, it is essential that it is supported by efficient lines of communication.

Worley and Doolen (2006) justify the importance of communication while Gillard

and Johansen (2013) articulate the importance of this aspect within the remit of construction project management.

CONCLUSIONS

With the continued redevelopment and expansion of urban centres articulated, in conjunction with the importance of the supply chain management process, the issue of getting the plethora of materials successfully onto site emerges and the importance of this research is compounded. On conducting a qualitative research methodology, a number of critical success factors emerge and are consolidated as follows; Lack of storage/offloading space to accommodate deliveries, and mutually agreeable delivery schedules outside peak congestion times. Where both on-site management and associated suppliers within urban environments interact, it is suggested that they identify the onerous difficulties in the lack of space for storage and offloading of materials in their delivery schedules. On-site management must be proactive and pre-emptive in the management of the set-down areas to accommodate such deliveries to site. This also suggests that suppliers strictly adhere to delivery schedules and timetabled distribution agreements with their various contractors, in order to assist the process of proactive on-site management to mitigate or eliminate such issues from emerging. To mitigate the various issues highlighted, the core strategy encouraged is the need to ensure that mutually agreeable delivery schedules outside peak congestion times are implemented, to maximise the efficiency of the delivery process while also considering the lack of space for contractor and supplier interactions.

Based on this preliminary study, a number of core recommendations emerge. Centred on the comments made by those questioned, it is essential that an efficient and updated delivery schedule is agreed, monitored and controlled by the various stakeholders in question. From this research, further investigation is necessary, particularly where both suppliers and contractors are questioned in unison through a focus group environment, to enable further detailed discussions, synergistic interactions and the identification of supplementary information to support the findings herein. As documented throughout, with the continuous development of urban centres and the maximisation of space within our confined construction sites, both contractors and suppliers are encouraged to adopt the points noted in the proactive management of the supply chain and the delivery of materials to site. Where such recommendations are acknowledged, it is envisaged that the delivery process of materials to site would be streamlined further, resulting in less waste, reduced interactions with the public and further refinement of the project schedule, thus increasing the probability of projects being completed as programmed.

REFERENCES

- Agapiou, A., Flanagan, R., Norman, G and Notman, D. (1998a), 'The Changing Role of Builders Merchants in the Construction Supply Chain' *Construction Management and Economics*, Vol. 16, No. 3, pp. 351-361.
- Agapiou, A., Clausen, L. E., Flanagan, R., Norman, G and Notman, D. (1998b), 'The Role of Logistics in the Materials Flow Control Process' *Construction Management and Economics*, Vol.16, No. 2, pp. 131-137.
- Akintoye, A. (1995), 'Just-in-Time application and implementation for building material management' *Construction Management and Economics*, Vol. 13, No. 2, pp. 105-113.

- Akintoye, A., McIntosh, G. and Fitzgerald, E. (2000), 'A Survey of Supply Chain Collaboration and Management in the UK Construction Industry' *European Journal of Purchasing and Supply Management*, Vol. 6, No. 3/4, pp.159-168.
- Ala-Risku, T. and Kärkkäinen, M. (2006), 'Material delivery problems in construction projects: A possible solution' *International Journal of Production Economics*, Vol. 104, No. 1, pp. 19–29.
- Assaf, S. A. and Al-Hejji, S. (2006), 'Causes of delay in large construction projects' *International Journal of Project Management*, Vol. 24, No. 4, pp. 349–357.
- Bloom, D. E. and Khanna, T. (2008), 'The Urban Revolution' *Finance and Development*, Vol. 44, No. 3, pp. 1.
- Bourne, L. S. (2010), '*Reurbanization, uneven urban development, and the debate on new urban forms*' Canada: Bellwether Publishing, Ltd.
- Bowersox, D. J. and Closs, D. J. (1996), '*Logistical managements: The integrated supply chain process*' USA: McGraw-Hill Companies.
- Brinkman, M., Dobbs, R., Oppenheim, J., Thompson, F. and Zornes, M. (2011), '*Resource revolution: Meeting the world's energy, materials, food and water needs*' USA: McKinsey Global Institute.
- Constructing Excellence (2006), '*Consolidation Centre*' [Online] Available at: <http://www.constructingexcellence.org.uk/zones/logisticszone/consolidationcentre.jsp> (Accessed: 2013, March 4).
- Gillard, S. and Johansen, J. (2013), 'Project Management Communication: a Systems Approach' *Journal of Information Science*, Vol. 30 No. 1, pp. 23-29.
- Gunhan, S. and Arditi, D. (2005), 'Factors Affecting International Construction' *Journal of Construction Engineering and Management*, Vol. 131, No. 3, pp. 273-282.
- Hancher, D. E. and Taylor, T. R. B. (2007), 'Night-time construction issues' *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1761, pp. 107-115.
- Jones, C. (1995), 'Urban Regeneration, Property Development, and the Land Market' *Environment and Planning C: Government and Policy*, Vol. 14, No. 2, pp. 269-279.
- Jones, P. and Evans, J. (2008), '*Urban Regeneration in the UK*' UK: SAGE Publications Ltd.
- Li, K., Zhang, P., Crittenden, J. C., Guhathakurta, S., Chen, Y., Fernando, H., Sawhney, A., McCartney, H., Grimm, N., Kahhat, R., Joshi, H., Jonjevod, G., Choi, Y. J., Fonseca, E., Allenby, B., Gerrity, D. and Toeens, P. M. (2007), 'Development of a Framework for Quantifying the Environmental Impacts of Urban Development and Construction Practices' *Environmental Science and Technology*, Vol. 41, No. 4, pp. 5130-5136.
- Morana, J. and Gonzalez-Feliu, J. (2010), '*Sustainable supply chain management in city logistics solutions: An experience's comeback from Cityporto, Padua, Italy*', Morocco: Laboratoire d'Economie des Transports.

- Peter Brett Associates (2007), '*Construction Consolidation Centres: An Assessment of the Potential for London wide use (Project Ref: 17321/004)*' UK: Transport for London.
- Roberts, P. W. and Sykes, H. (2000), '*Urban Regeneration: A Handbook*' UK: SAGE Publications Ltd.
- Sears, S. K., Clough, R. H. and Sears, G. A. (2008), '*Construction Project Management: A Practical Guide to Field Construction Management*', 5th Ed., New Jersey: John Wiley & Sons.
- Spillane, J. P., Oyedele, L. O., Von Meding, J. K. and Konanahalli, A. (2010), '*Material Management in Confined Site Construction*' *Proceedings of the Construction, Building and Real Estate Research Conference of the Royal Institution of Chartered Surveyors (RICS)*, Sept. 2-3 2010, Dauphine Université, Paris.
- Spillane, J. P., Oyedele, L. O., Von Meding, J., and Konanahalli A. (2011), '*Challenges of UK/Irish contractors regarding material management and logistics in confined site construction*', *International Journal of Construction Supply Chain Management*, Vol. 1, No. 1, pp. 25-42.
- Swaminathan, J. M., Smith, S. F. and Sadeh, N. M. (1998), '*Modeling Supply Chain Dynamics: A Multiagent Approach*' *Decision Sciences*, Vol. 29, No 3, pp. 607–632.
- United Nations (2010), '*World Urbanisation Prospects – The 2009 Revision – Highlights*' USA: United Nations, Department of Economic and Social Affairs, Population Division.
- United Nations (2012), '*World Urbanisation Prospects – The 2011 Revision – Highlights*' USA: United Nations, Department of Economic and Social Affairs, Population Division.
- Worley, J. M. and Doolen, T. L. (2006), '*The role of communication and management support in a lean manufacturing implementation*', *Management Decision*, Vol. 44, No. 2, pp. 228 – 245.
- Voordijk, H., de Haan, J. and Joosten, G-J (2000), '*Changing Governance of Supply Chains in the Building Industry: A Multiple Case Study*' *European Journal of Purchasing and Supply Management*, Vol.6, No. 3/4, pp. 217-225.
- Vrijhoef, R. and Koskela, L. (2000), '*The Four Roles of Supply Chain Management in the Construction Industry*' *European Journal of Purchasing and Supply Chain Management*, Vol. 6, No.3/4, pp. 159-168.